

Air Quality in Europe, China, South East Asia and Australia

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Introduction

Air pollution continues to be an issue of concern throughout the world although the extent to which steps are taken to control emissions vary greatly from country to country. In Europe, for example, certain emissions have been reduced in some countries but not in others. In Stockholm pollutants from urban traffic have been under control for some time by managing traffic flow, using catalysts and improving engine efficiencies. In other cities, for example Beijing, the increase in traffic density will add to current pollution issues.

Volatile organic compounds (VOCs) contribute to overall air pollution both indoors and outdoors and can be derived from many sources. Coming Hazleton has performed a large number of fixed site measurements throughout Europe, China, South East Asia and Australia both inside and outside the homes of city residents. Up to 34 VOCs have been quantified.

Concurrent measurements using personal monitors were also undertaken with at least 200 subjects in each city volunteering to wear air samplers over a 24 hour period. Personal exposures to respirable suspended particles (RSP at PM_{10}), environmental tobacco smoke (ETS) particles and nicotine were made. As of December 1996, investigations have been completed in Stockholm, Barcelona, Turin, Paris, Bremen, Lisbon, Basle, Prague, Kuala Lumpur, Hong Kong, Sydney and Beijing. This paper compares some of the findings for these cities.

Methods

Volunteer Selection

Marketing databases were used to select representative subjects to participate on these studies. A segmentation system called MOSAIC (CCN Marketing Nottingham) England was used by MarknadsAnalyt of Stockholm to verify that the sample population was geodemographically representative of each city (Phillips et al 1996). To our knowledge it is the first time that marketing information has been used to select volunteers for this type of scientific study on air quality and pollution.

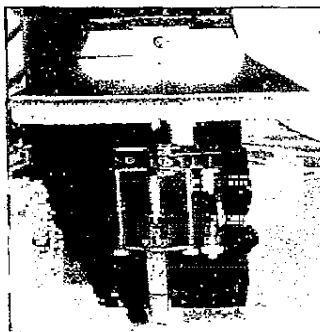
Training Session

Once selected, the volunteers were given an appointment to attend an information / training session at a centrally located venue in each city. Here they were shown an instructional video and provided with details of how to complete the questionnaires. At this stage the monitoring equipment was provided and saliva samples were taken from each subject for cotinine analysis (a metabolite of nicotine). At the return session, equipment was checked, further questionnaires completed and a final saliva sample taken.

CELL	CATEGORY	SMOKING STATUS	
		Home	Workplace
1	Housewife	Smoking	-
2	Housewife	Non-smoking	-
3	Office worker	Smoking	Smoking
4	Office worker	Smoking	Non-smoking
5	Office worker	Non-smoking	Smoking
6	Office worker	Non-smoking	Non-smoking

24 Hour Sampling

Sampling was performed over a 24 hour period either using a single personal monitor for the housewife group or using two personal monitors sequentially over the same time period for office workers. These two groups were then split into six cells as shown above.



Fixed site sampler

Personal Monitor

The personal monitor was used to collect RSP and nicotine from the air close to the breathing zone of the wearer. ETS particles contributing to total RSP were estimated using solanesol measurements on extracts of the RSP collected on the filter. Air was also drawn through a separate glass tube containing sorbent material for the collection of certain vapour phase components of ETS, nicotine in particular. The sampler head was connected to a battery operated pump, housed within a polypropylene dry-box containing polyurethane foam for protection and sound insulation, by a coiled polyurethane tube.

VOC Sampling

VOCs were sampled for 24 hours both inside and outside the homes of recruited housewives taking part on the personal monitor study. A variety of indoor locations were sampled particularly the living areas and kitchen. Additional to VOC sampling, concurrent fixed site measurements of RSP, ETS particles and nicotine were performed using an identical sampling head to that used with the personal monitor.

Analysis

RSP at PM_{10} were trapped on a Fluoropore membrane filter and the weight collected determined to the nearest microgram. Particle size discrimination was achieved using a 10mm Dor-Oliver cyclone.

ETS contribution to RSP was estimated in three ways using HPLC techniques: Estimates based upon solanesol content, UV absorbance and fluorescence of filter extracts, performed using methanol, were converted to quantities of ETS particles using predetermined factors.



Housewife volunteer, Beijing

Nicotine was extracted from the sorbent resin using ethyl acetate and quantified using capillary gas chromatography with thermionic specific detection (Ogden, 1989).

VOCs were sampled using a briefcase containing two independent battery operated pumps. One pump was connected to a sampling head identical to that on the personal monitor and the other to a series of three thermal

desorption tubes. Following desorption (ATD40D) the VOCs were analysed by GC/MS.

Saliva cotinine concentrations were quantified using radioimmunoassay, saliva samples being incubated with anti-cotinine anti-serum and 3H -cotinine and the bound fraction subsequently separated using a second antibody followed by centrifugation. Radioactivity present in the supernatant was determined using a liquid scintillation counter (Van Vunakis, 1987).

Australia

For Australia only, the protocol was changed such that each volunteer wore a single personal monitor during the sampling period. The volunteers were recruited into one of four groups.

- 1) Housewives
- 2) Office workers
- 3) Elsewhere or non-residential
- 4) 24 hour sample

In (1) and (2) the volunteers only had the monitor on whilst at home (1) or at work (2). In (3) the monitors were worn anywhere outside the home and workplace e.g. whilst travelling, at leisure etc. In (3) it was assumed the activity would only be for about 2 or 3 hours a day therefore the monitors

Subjective ETS
assessment not
mentioned

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Findings

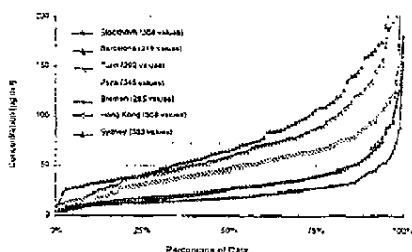
GRUP	Losylos	Medios	RON porcentaje
Reyes	6	1.4	1.7
Ortiz	7	1.5	1.8
Escobar	8	1.23	1.7
Alcalá	9	1.4	1.7

Age Group	not interested	neutral	open change	yes, I will do it
18-24	1	1	1	1
25-34	2	2	2	2
35-44	3	3	3	3
45-54	4	4	4	4
55-64	5	5	5	5
65-74	6	6	6	6
75-84	7	7	7	7

Category	All respondents	18-24	25-34	35-44	45-54
All respondents	100	100	100	100	100
18-24	100	100	100	100	100
25-34	100	100	100	100	100
35-44	100	100	100	100	100
45-54	100	100	100	100	100

Year	All Publications	Non-English Publications	English Publications
1980	2	1	1
1981	3	2	1
1982	4	3	1
1983	5	4	1
1984	6	5	1
1985	7	6	1
1986	8	7	1
1987	9	8	1
1988	10	9	1

Fig 7 : Benzene : Outside



	95th percentile				Median			
	SW	NSW	SE	ESSE	SW	NSW	SE	ESSE
Barrenness	236	21	123	156	34	13	79	46
Tree	256	120	113	38	30	44	71	43
Peas	156	156	142	38	67	42	41	15
Hard Work	124	30	100	106	41	39	54	15
Grass	119	31	10	81	27	29	14	13
Shy	79	46	34	34	1	30	39	1
Stomach	57	35	79	15	0	16	31	19

SW = jumping distance
 NSW = normal and horse
 SE = jumping time
 ESSE = normal and horse

Fig. 1: Distribution of Environmental Tobacco Smoke (ETS) Particles

We have collected VOC samples from the homes of more than 250 volunteers on the personal monitoring studies in ten cities. This results in a unique database containing more than 25,000 individual, quantifiable VOC results. Figures 5, 6 and 7 are based on concentration plots of median levels (left to right) of benzene inside smoking households (figure 5), inside non-smoking households (figure 6), and outside concentrations (figure 7). Preliminary indication is that there is very little difference between the benzene levels in smoking and non-smoking homes but that indoor levels are the indoor levels are much higher than the outdoor. Statistical evaluation of the data currently is under way. In numerous publications are

Acknowledgements

The first of the three new methods was developed by the author for AC and BC and is described in [1].

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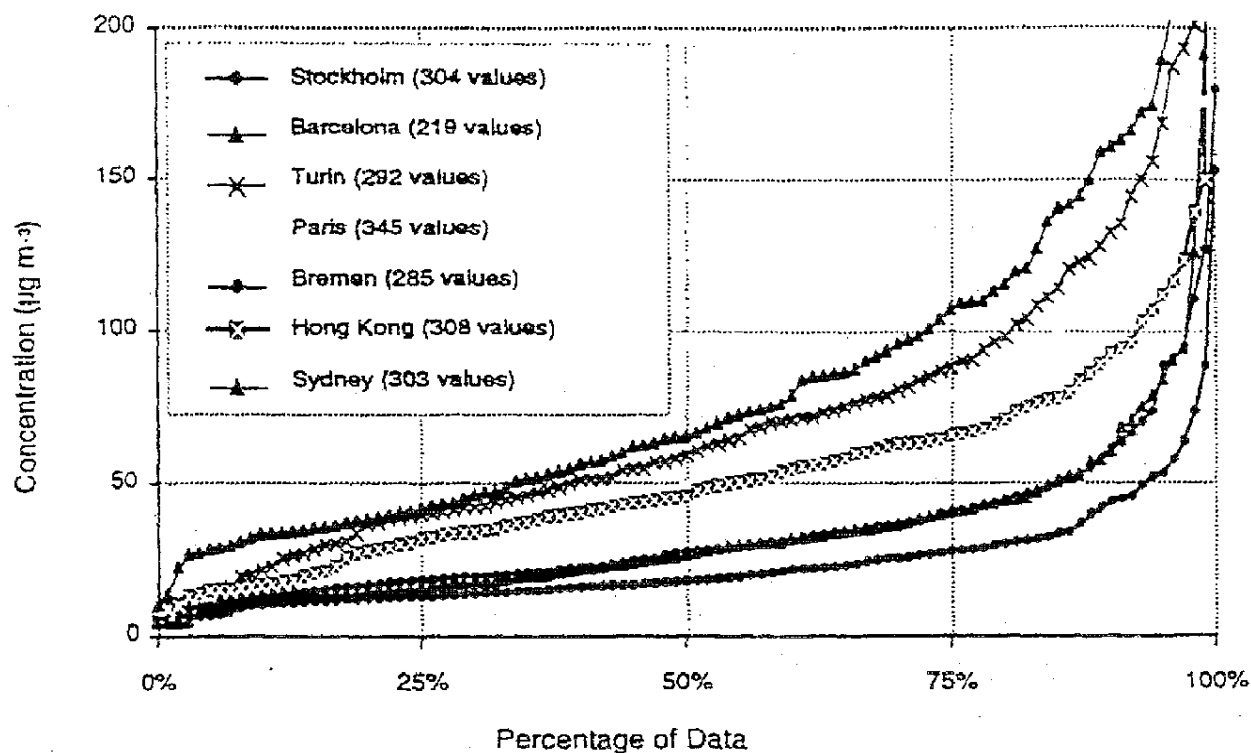


Fig 1 : Distribution of Respirable Suspended Particles (RSP)

	95th percentile				Median			
	SW	NSW	SH	NSH	SW	NSW	SH	NSH
Barcelona	236	91	173	136	94	52	73	46
Turin	216	120	183	99	90	64	71	48
Paris	159	105	142	88	63	53	62	33
Hong Kong	134	90	100	106	51	38	54	45
Bremen	118	91	90	51	37	23	36	23
Sydney	74	50	83	65	34	15	30	24
Stockholm	57	55	72	45	16	16	31	19

SW = smoking workplace

SH = smoking home

NSW = nonsmoking workplace

NSH = nonsmoking home

Fig 2 : Respirable Suspended Particle (RSP) Concentrations by City

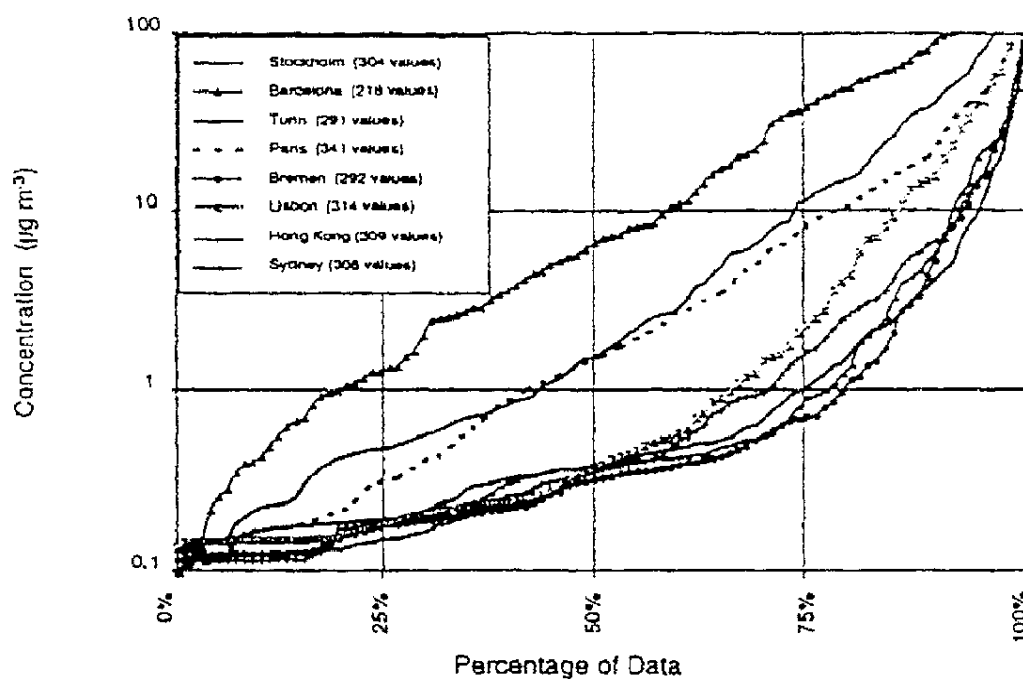


Fig 3 : Distribution of Environmental Tobacco Smoke (ETS) Particles

GROUP	Analyses	Median	90th percentile
Home	76	0.06	0.77
Work	77	0.15	0.39
Eisewhere	78	0.23	1.29
24 Hour	78	0.06	1.01

Fig 4 : Nicotine Concentrations in Sydney ($\mu\text{g m}^{-3}$)

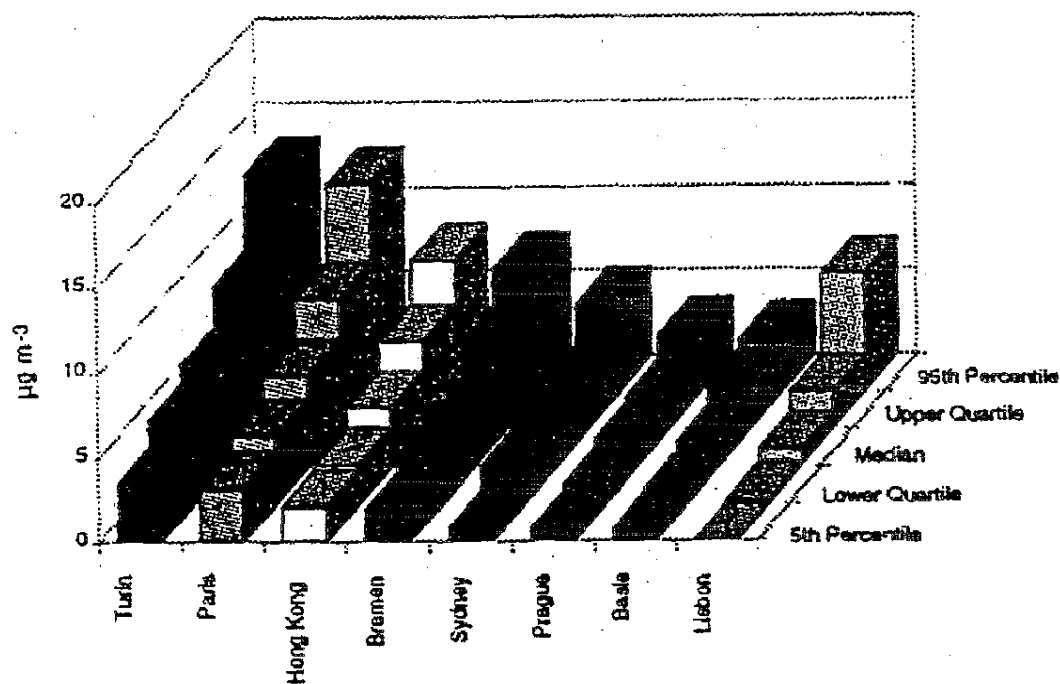


Fig 5 : Benzene : Smoking Household - Inside

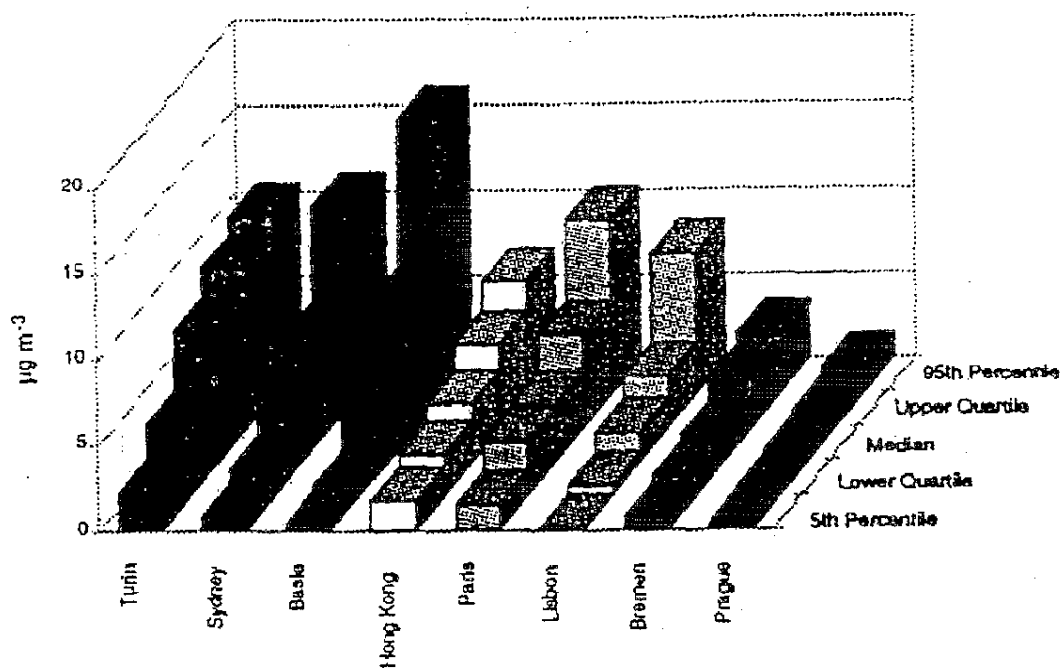


Fig 6 : Benzene : Non-smoking Household - Inside

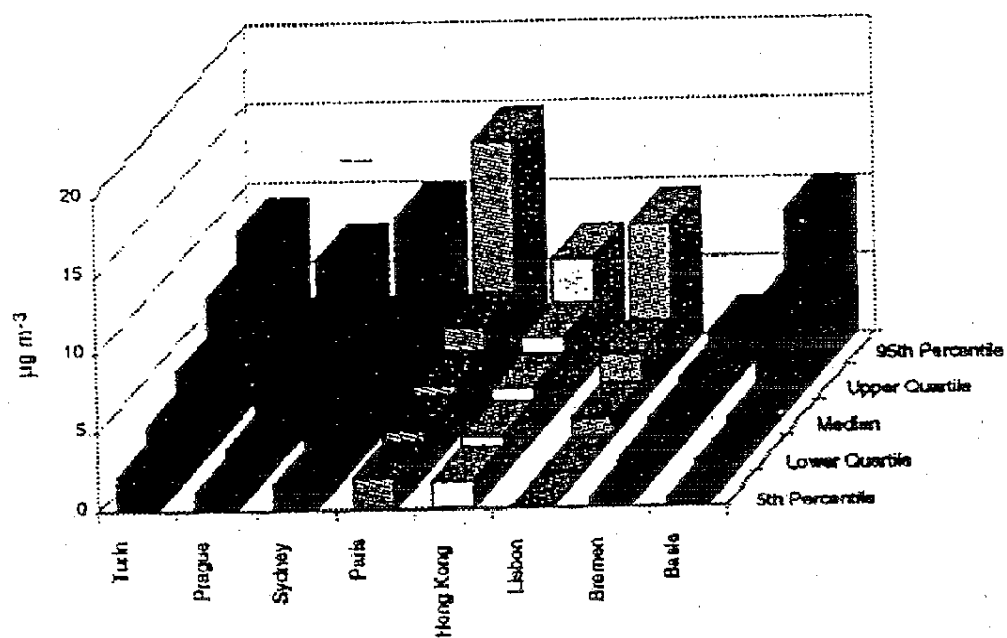


Fig 7 : Benzene : Outside